OAR Box 1219

Prepped by Ollie Stewart

Document Number:

196) IV-B-3

Docket Number:

A-91-46

A-91-46
IV-B-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 7 1992

MEMORANDUM

OFFICE OF
AIR AND RADIATION

SUBJECT: Discussion of EPA Statistical Tests on Ford Data

FROM: John W. Holley, Chief
Data Management and Analysis Section, FOSD

TO: Docket A-91-46

This memorandum describes the five statistical tests which were performed by EPA on the hydrocarbon (HC) data from Ford's test program on the additive MMT and briefly discusses the results of those analyses. The five tests are a subset of the larger group of tests used by EPA in evaluating the data contained in an earlier (1978) waiver application for MMT and employed by Ethyl in its 1990 application. The tests included were:

1. The "difference of slopes" test

2. The "deterioration factors" test

3. The "violation mileage" test

4. The "maximum percentage failing the standard" test

5. The "cause or contribute" test

Since the tests employed are all based on regression analysis, some decisions were necessary regarding what data to include. For vehicles certified to a 50,000 mile useful life we would normally perform the regression analysis only on data gathered in the first 50,000 miles of use. Because the Ford test program collected data at widely separated mileage points, we determined that it would be most appropriate to include the data on the Escort vehicles collected at 55,000 miles, even though that mileage is outside of the useful life of those vehicles. To restrict the analysis to data under 50,000 miles would have required extrapolation from the last data point before that mileage (at 20,000 miles) and would seem to very poorly represent what happened to the vehicles as they reached higher mileages. An additional justification for this decision is that the MMT-containing fuel was not introduced into the experimental vehicles until they had accumulated 5,000 miles--so the 55,000 mile data point does reflect 50,000 miles of operation on the additive. For the Explorers, with their 120,000 mile useful life, we used data out to the highest mileage tested by Ford, 105,000 miles. A description of each of the tests and the HC results from them follows.

1. "Difference of slopes" test: This test consists of computing linear regressions for each vehicle group/fuel type combination and then statistically examining the differences between the clear and MMT regression slopes in light of the strength of the individual curve fits. The additive is considered to have failed the test for a vehicle group if the MMT slope is higher than the clear slope and the difference is significant at the 0.05 significance level (we used a 1-tailed test, since only a difference in one direction generates a failure). The significance level used means that only five times in one hundred such samples would we obtain slopes as different as these by chance alone if in fact the slopes in the population were identical.

In this analysis both the Escorts and the Explorers failed the test for HC by a considerable margin. In both cases the relevant "t" statistic was several times the appropriate critical value.

2. "Deterioration factors" test: This test examines the regression-predicted 50,000 mile emissions (120,000 mile emissions for the Explorers) and the regression-predicted 4,000 mile emissions, and divides the former by the latter to obtain a deterioration factor (DF) similar to those used in certification. The DFs for clear and MMT fueled vehicles in a vehicle model group are compared, and if the MMT fueled vehicles have the higher DF, the additive is considered to have failed for this model group.

Both Escorts and Explorers fail this test for HC with considerable margins. The Escort MMT-fueled DF was 50% higher than that for the clear fueled Escorts. The Explorer MMT-fueled DF was over three times the size of the DF for the clear-fueled Explorers.

3. "Violation mileage" test: In this test the regression line relating HC emissions to mileage is examined for each vehicle model/fuel combination to determine the mileage at which the regression model predicts exceedance of the applicable standard (regression line crosses the standard). Evaluation of each model group is performed by determining whether violation is predicted earlier for vehicles using MMT. If the vehicle model/fuel group initially fails, its violation mileage is 0. If it is under the standard at the end of the applicable useful life, then no violation is considered to have occurred.

For the Escorts the violation mileage was higher than the 50,000 mile useful life, and thus the group passes the test for HC. The Explorer regression line, on the other hand, crossed over the standard at about 109,000 miles and short of its 120,000 mile useful life (clear fueled Explorers did not fail until almost a half-million miles). The Explorers thus failed this test.

4. "Maximum percentage of vehicles failing the standard" test: Like the previous test, this test is based upon the relationship between the mileage regression lines for the two fuel groups and the standard. Regression lines are computed by vehicle model/fuel type. The variability about the regression line is used to estimate the percentage of the fleet that could be expected to fail the standard at the mileage where the regression line is highest (within

the useful life of the vehicle model). If the slope is negative, that point will be 0 miles and if positive that point will be 50,000 miles (Escorts) or 120,000 miles (Explorers). If the highest value for MMT fuel is higher than that for clear fuel, that vehicle model group fails.

Since the MMT slope is steeper than the clear fuel slope for both of the models being considered here, the test comes down to whether some failures are predicted to occur in the MMT-fueled test groups before they reach the end of their useful lives. In both models this happened and the models failed the test for HC. For the Escorts 1.3% are predicted to fail before 50,000 miles, while 72% of the Explorers were expected to fail before 120,000 miles.

5. "Cause or contribute" test: The so-called "cause or contribute" test is methodologically virtually identical to the test discussed previously in that the same regression lines are determined and the variance about those lines established so that a prediction can be made about the proportion of the population in the model/fuel group likely to exceed a fixed standard. This test simply establishes a ten percent criterion for the percentage of the MMT-fueled vehicles in a model group predicted to fail before the end of their useful life. If the predicted proportion failing for the MMT group exceeds ten percent before the clear fueled group, and does so within the useful life, then the model group fails the test.

The result for this test is different from that for the last test because of the ten percent criterion; the Escorts fell short of ten percent and passed the test while the Explorers substantially exceeded the ten percent and failed.